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Agricultural Experiment Station
University of Kentucky

THE RELATION OF SOME CHEMICAL CONSTITUENTS TO THE GRADES OF KENTUCKY TOBACCO.

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BULLETIN NO. 258

The Relation of Some Chemical Constituents to the Grades of Kentucky Tobacco

By O. M. SHEDD.*

The tobacco grown as a farm crop in Kentucky is of two kinds, namely, the burley, which is produced chiefly in the blue-grass region of the central area, and the dark types, which are raised extensively in the western section. It should not be understood, however, that only burley tobacco can be grown in central Kentucky and only dark tobacco in western Kentucky, for experience has shown that both can be produced in either section. However, as far as quality is concerned, each kind appears to be best adapted to the soils of that area in which it commonly is grown.

Most of the burley tobacco grown in Kentucky is used in this country, whereas most of the dark tobacco is exported. The demand for the smoker grades in this country has increased recently and, on this account, those strains of burley tobacco which produce a very light-colored leaf, suitable for use in blends for the manufacture of cigarettes and high-grade smoking tobacco, are highly desirable.

As is well known, tobacco has been sold for a long time by grade. Good grading requires a knowledge of quality and of the probable uses by the trade for certain types. A crop that has been graded properly always commands a higher price than a poorly graded one, for the buyer can more easily appraise its

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value; moreover, he does not incur the expense of regrading. The principal recognized classes of burley tobacco are known as wrappers, fillers and smokers; those of dark tobacco, as leaf, lugs and trash. The nondescript tobacco in a crop should be and generally is separated from the remainder.

In the present investigation an attempt is made to correlate some chemical factors of our tobacco with its quality as ordinarily distinguished by the market grades.

HISTORICAL NOTE

References in the literature pertaining to the chemical analysis of various kinds of tobacco are numerous. The chemical work on burley tobacco and dark varieties similar to those produced in Kentucky is more limited and generally represents the leaves of the entire plant rather than those obtained from certain sections of the stalk which go into the different grades. A few examples of investigations of this kind, carried on in neighboring states as well as here, are of interest in connection with this work.

Carpenter (3)* made a comparison of the percentages of nicotine, nitrate and certain mineral constituents of white burley tobacco grown in Ohio, West Virginia and Kentucky.

Davidson (4) determined the mineral constituents and nicotine of white burley and dark types of Virginia tobacco at different stages of growth and in different parts of the plant.

Graham and Carr (5) compared the content of nicotine, ash and certain extractives in Wisconsin white burley, Kentucky white burley, Kentucky dark tobacco, and improved burley grown in Indiana.

Peter (Robert) (6), analyzed the ashes of 28 samples of cured leaf tobacco grown in different parts of Kentucky, the object being to correlate, if possible, the chemical composition of the ash with that of the soil upon which the crop was grown, and to estimate the amount of mineral plant food removed in the crop. Most of these samples, presumably, were what we call dark tobacco. As this work was done in 1858, about ten years

*Reference is made by number to literature cited, p. 57.

before the appearance of white burley tobacco in Kentucky (2), this was long before the present system of grades was introduced.

The results of the foregoing investigations show that the same kind of tobacco varies in composition according to the soil upon which it is grown.

SIGNIFICANCE OF THE GRADES OF TOBACCO

The lower leaves of the burley tobacco plant, which supply the bulk of the smoker grades, are of light color and weight; the upper leaves, which go into the filler grades, are heavier and darker in color than the lower. The tips may go into either class, depending upon color and other characters. The wrappers are selected from both the smoker and filler grades and are known as cigarette wrapper and twist wrapper, respectively. A better understanding of the different grades can be obtained by referring to the principal ones of the Burley Tobacco Growers Cooperative Association, as defined for the 1921 crop: A (flyings); B (trash); C (lugs); D (bright leaf); E (red leaf); F (heavy tips); FS (smoking tips); CW (cigarette wrapper); and TW (twist wrapper). Each of these grades except the tips and wrappers consists of seven classes, referred to by numerals, of which No. 1 denotes best and No. 7, poorest. Generally speaking, the first two numerals indicate good, the next three medium, and the last two common, of each grade. The samples used in this work for good, medium and common are represented by Nos. 1, 4 and 7, respectively, under the different grades.

Grades A, B and C are smokers, D, either smokers or fillers, depending upon the manufacturers' standard, and E, fillers. Cigarette wrappers are largely obtained from the best C and D grades and twist wrappers from the best D and E grades. It will be noted that the bright leaf, or D grade, divides the smokers and fillers and that it is sometimes used for both.

The grade of wrapper, in burley tobacco, is subdivided into No. 1, good and No. 2, medium, no burley common wrapper being recognized. This is because an exceptional quality of leaf is required for wrappers. On account of its scarcity, this

grade always sells for the highest price. A medium wrapper usually is distinguished from the good by one or more of the following characters: smaller size, darker color, coarser texture, less elasticity, less luster or oily appearance. As differences in appearance between the good and medium of this grade were not as marked as in the other grades used because there are fewer subdivisions in the wrappers, this may account for the smaller differences in some of the results obtained on wrappers.

The relative market value of the grades is to a large extent reflected in the loan values advanced by the Association on the 1921 crop. The loan value in dollars per hundred pounds, on No. 1 of each grade, was as follows: A=16; B=18; C=22; D=20; E=14; F=7; FS=8; CW=26; and TW=20. The sale price was, of course, higher than the loan value but the relations as given above probably held true thru the grades, showing that the smokers sold for more than the fillers.

The dark tobacco is graded differently from the burley but, generally speaking, the leaf, lugs and trash of both occupy the same relative positions on the stalks. The number of leaves that go into each grade, however, is different in the two kinds, on account of the manner in which they are topped and the different purposes for which they are used.

OBJECT AND PLAN OF THE INVESTIGATION

It was thought that a study of the content of certain chemical constituents in the various grades, in order to determine if distinct differences could be found that would distinguish them as clearly as their physical properties, would be of interest.

Burley and dark tobacco from the crops grown in 1920 and 1921 was used in the work. The burley tobacco used consisted of the various strains of white burley produced in the bluegrass region, while the dark tobacco included several varieties, both air-cured and fire-cured, grown in western Kentucky. It was intended to work on only the 1920 crops but as both were abnormal, particularly the burley, due to the presence of wildfire and angular leaf-spot, the work was repeated on the 1921 crops. The latter were more nearly normal altho these diseases were

more or less present but mostly in the common grades. The samples of dark tobacco in both years were freer of disease than the burley.

A study of both kinds of tobacco grown during the two years has, therefore, made possible a comparison of normal versus abnormal leaf and, at the same time, of yearly differences in constituents, particularly of the good grades; for the good samples used in this investigation, even from the 1920 crop, were rarely infected with disease.

The procedure followed in obtaining the samples for this work was to have different expert graders, representing growers, warehouses and manufacturers, select "hands" of good, medium and common of the various grades; consequently, the samples represent the composite judgment of expert graders of each kind of tobacco. This is particularly true concerning the 1921 burley crop, since the writer had the valuable assistance of the Association graders who selected practically all samples.

The samples were prepared for analysis by air-drying the "hands" at room temperature and, after the midrib, commonly known as the stem, had been removed and discarded, the leaf was ground to a fine powder and put into sealed jars. Only a few were sampled at one time and the analyses were made as soon thereafter as possible. Composite samples for the ash analyses were made up of equal weights of all individual samples of each grade, after grinding.

The constituents determined were total nitrogen, nicotine and nitrate nitrogen in the individual samples; also crude ash, silicon, phosphorus, potassium, calcium and magnesium in composite samples representing good and common of each grade.

METHODS OF ANALYSIS

Moisture. A weighed portion of the powdered sample was dried in a slow current of natural gas for 7 hours in an oven surrounded by boiling water (about 98° C.).

Total Nitrogen. Kjeldahl method modified to include nitrate (1, pp. 7-8). Salicylic acid and sodium thiosulfate were

used in the digestion and sodium alizarin sulfonate indicator in the titration.

Nicotine. A method devised by the writer (7) which combines the good features of the Kissling and regular silicotungstic acid methods.

Nitrate Nitrogen. Strowd's Devarda alloy method modified by the writer (8).

Crude Ash. This was determined in the usual manner by ashing the sample at low red heat to constant weight.

Silicon. The silica was obtained in the usual manner from the hydrochloric acid solution of the crude ash by dehydration and subsequent treatment with hydrofluoric acid.

Phosphorus. This was determined volumetrically in an aliquot of the filtrate from the silica determination, by precipitating as ammonium phosphomolybdate, at 40° C., and standing over night at room temperature before filtering. After filtering and washing the precipitate, it was treated with an excess of standard alkali and titrated with standard acid and phenolphthalein indicator (1, p. 18, method III).

Calcium. The filtrate and washings from the ammonium phosphomolybdate were made slightly alkaline with ammonium hydroxid, heated to 40° C. for some time and filtered after standing overnight at room temperature. The precipitate of ferric and aluminum hydroxids thus formed was filtered, washed once or twice, dissolved in hydrochloric acid and reprecipitated in the same manner. The two filtrates from the ferric and aluminum hydroxids, without concentrating, were combined, heated, and hot ammonium oxalate solution added. After standing overnight at room temperature, the calcium oxalate was filtered and the precipitate dissolved in hydrochloric acid and reprecipitated in the same manner but in a smaller volume. The calcium was determined volumetrically by treatment of the calcium oxalate with dilute sulfuric acid, heating, and titrating with standard potassium permanganate solution in the usual manner. (1, p. 17, Method II, modified.)

Magnesium. The combined filtrates from the calcium oxalate were made slightly acid with hydrochloric acid, evaporated

to dryness and ammonium salts eliminated at low heat. Dilute hydrochloric acid was added and the residue of molybdenum trioxid was filtered and washed. The manganese in the concentrated filtrate was eliminated by repeated addition of bromin water and ammonium hydroxid. The residue was filtered and washed and the magnesium determined in the solution gravimetrically as magnesium pyrophosphate. (1, pp. 17, 18, Method II.)

Control determinations were made to estimate the impurities in the reagents and these have been deducted in reporting the results in the tables.

RESULTS OF THE ANALYSES

The findings for total nitrogen, nicotine and nitrate nitrogen, obtained on the individual samples, are given in tables 1 to 12, inclusive. The averages of these findings in each grade and for burley and dark tobacco, for each year, including all grades, are grouped in Tables 13 and 14.

The percentages of mineral constituents in the composite samples representing the good and common of each grade are in Tables 15 and 16. The average percentages of mineral constituents found in all the samples analyzed from the 1920 and 1921 crops, including all grades, are in Table 17.

Each horizontal line in the tables compares samples taken by one grader; therefore the comparisons between good, medium and common samples in any single line are based on the judgment of one man. The selections made by any one grader may appear in several tables, however, or more than once in the same table.

TABLE 1.—Burley Wrapper, Moisture-Free, 1920 Crop.

Number of Sample	Good			Medium		
	Total N Per Cent	Nicotine Per Cent	Nitrate N Per Cent	Total N Per Cent	Nicotine Per Cent	Nitrate N Per Cent
61339a, 40a	4.50	3.28	.179	4.21	4.49	.148
61347b	.....	.....	.....	3.70	3.67	.235
61348a, 9a	2.96	3.30	.063	3.28	3.44	.186
61350c	.....	.....	.....	3.83	4.61	.077
61367c	5.27	3.72	.275	.....	.....	.....
61375a, 6a	4.27	4.00	.308	5.34	4.03	.812
61377c	4.12	3.91	.196	.....	.....	.....
61401a	.....	.....	.....	4.08	4.11	.085
61409a	3.41	3.70	.235	.....	.....	.....
61417d	3.85	5.49	.285	.....	.....	.....
61418e	5.33	4.07	.494	.....	.....	.....
Maximum	5.33e	5.49d	.494e	5.34a	4.61c	.812a
Minimum	2.96a	3.28a	.063a	3.28a	3.44a	.077c
Average	4.21	3.93	.254	4.15	4.14	.262

a—Cigarette wrapper.

b—Cigarette wrapper, 1919 crop, omitted from average.

c—Twist wrapper.

d—Light plug wrapper, grown in Illinois.

e—Plug wrapper.

TABLE 2.—Burley Wrapper, Moisture-Free, 1921 Crop.

Number of Sample	Good			Medium		
	Total N Per Cent	Nicotine Per Cent	Nitrate N Per Cent	Total N Per Cent	Nicotine Per Cent	Nitrate N Per Cent
80117a, 9a	4.30	3.37	.466	4.38	2.80	.958
80118a, 20a	4.16	3.83	.569	4.22	3.75	.657
80246a, 7a	2.53	2.48	.047	3.48	4.21	.042
80292b, 3b	4.82	5.28	.498	4.18	5.64	.425
80325a, 6a	3.64	3.96	.255	4.06	4.40	.372
80348a	.....	.....	.....	3.32	2.98	.066
80349b	.....	.....	.....	3.99	3.53	.076
80433a	.....	.....	.....	3.34	3.92	.373
Maximum	4.82b	5.38b	.569a	4.38a	5.64b	.958a
Minimum	2.53a	2.48a	.047a	3.32a	2.80a	.042a
Average	3.89	3.80	.367	3.87	3.90	.375

a—Association grade C W (cigarette wrapper).

b—Association grade T W (twist wrapper).

TABLE 3.—Burley Filler, Moisture-Free, 1920 Crop.

Number of Sample	Good			Medium			Common		
	Total N Per Cent	Nicotine Per Cent	Nitrate N Per Cent	Total N Per Cent	Nicotine Per Cent	Nitrate N Per Cent	Total N Per Cent	Nicotine Per Cent	Nitrate N Per Cent
61243, 4, 5	4.47	3.91	.293	3.72	4.23	.056	3.84	1.89	.157
61351a, 2a	3.69	4.16	.061	.....	.....	.....	5.02	5.47	.216
16353, 4, 5	6.05	5.08	.417	3.93	3.77	.088	3.97	2.80	.066
61356b, 7b	4.28	2.45	.357	.....	.....	.....	4.59	1.83	.122
61366a	4.28	5.25	.208	.....	.....	.....	.....	.....	.....
61368, 9	5.39	3.50	.456	.....	.....	.....	4.58	3.70	.098
61378, 9	.....	.....	.....	5.57	4.40	.406	4.22	2.94	.200
61405, 6	.....	.....	.....	4.11	3.88	.143	4.28	3.11	.102
61407c	.....	.....	.....	.....	.....	.....	4.84	2.83	.184
61537, 8, 9	4.38	6.18	.120	4.57	3.71	.548	4.11	2.80	.045
61640, 1	4.78	3.86	.735	.....	.....	.....	4.13	4.34	.095
61644, 5	.....	.....	.....	3.10	4.72	.039	3.22	3.38	.009
Maximum	6.05	6.18	.735	5.57	4.72	.548	5.02a	5.47a	.216a
Minimum	3.69a	2.45b	.061a	3.10	3.71	.039	3.22	1.83b	.009
Average	4.88	4.16	.396	4.17	4.12	.213	4.18	2.96	.108

a—1919 crop, omitted from average.

b—Grown in Indiana.

c—Tips.

TABLE 4.—Burley Filler, Moisture-Free, 1921 Crop.

Number of Sample	Good			Medium			Common		
	Total N Per Cent	Nicotine Per Cent	Nitrate N Per Cent	Total N Per Cent	Nicotine Per Cent	Nitrate N Per Cent	Total N Per Cent	Nicotine Per Cent	Nitrate N Per Cent
80121, 2, 3	4.60	3.68	.525	4.96	3.13	.251	4.70	3.63	.253
80129, 30, 31	5.76	4.43	.520	5.26	4.24	.614	5.66	2.90	.597
80248a, 9a, 50a	5.64	3.33	.579	5.39	3.51	.320	4.51	2.47	.637
80271a, 2a, 3a	4.42	4.62	.658	4.22	2.81	.231	4.24	2.93	.648
80294a, 5a, 6a	5.33	3.44	.429	5.24	3.00	.239	4.76	3.04	.605
80327a, 8a, 9a	4.95	4.21	.492	4.63	3.18	.365	3.75	1.92	.168
80350a, 1a, 2a	5.33	3.48	.895	4.05	3.70	.277	4.61	3.83	.284
80434b, 5b, 6b	4.06	3.59	.209	4.87	3.52	.613	3.53	2.36	.735
80437b, 8b, 9b	3.62	3.32	.260	3.88	4.25	.197	4.16	2.22	.843
Maximum	5.76	4.62a	.895a	5.39a	4.25b	.614	5.66	3.83a	.843b
Minimum	3.63b	3.32b	.209b	3.88b	2.81a	.197b	3.53b	1.92a	1.68a
Average	4.86	3.79	.507	4.72	3.48	.345	4.44	2.81	.519

a—Association grade E (red leaf).

b—Association grade D (bright leaf).

TABLE 5.—Burley Smoker, Moisture-Free, 1920 Crop.

Number of Sample	Good			Medium			Common		
	Total N Per Cent	Nicotine Per Cent	Nitrate N Per Cent	Total N Per Cent	Nicotine Per Cent	Nitrate N Per Cent	Total N Per Cent	Nicotine Per Cent	Nitrate N Per Cent
61341, 2	.....	.....	.....	3.96	3.52	.147	3.11	2.55	.067
61358, 9, 60	2.79	1.50	.024	3.86	1.75	.242	3.16	1.37	.312
61370, 1	3.40	.84	.125	.....	.....	.....	3.17	1.32	.046
61380, 1, 2	3.65	2.50	.438	2.96	2.84	.076	3.44	2.36	.072
61402, 3, 4	3.39	3.16	.070	2.74	1.05	.111	2.66	1.32	.141
61411a	.....	.....	.....	.....	.....	.....	4.36	1.17	.246
61419, 20	2.95b	4.46b	.068b	.....	.....	.....	2.93a	.94a	.087a
61540, 1, 2	3.30	2.68	.356	2.79	2.25	.290	2.51	1.47	.135
61642, 3	3.42	4.26	.069	.....	.....	.....	3.13	2.04	.287
61646, 7, 8	2.80	1.75	.022	2.31	1.23	.081	3.87	1.33	.360
Maximum	3.65	4.46b	.438	3.96	3.52	.290	4.36a	2.55	.360
Minimum	2.79	.84	.022	2.31	1.05	.021	2.51	.94a	.046
Average	3.21	2.64	.149	3.10	2.11	.150	3.23	1.59	.175

a—Badly infected with wildfire and more so than other samples of this grade in this table.

b—Grown in Virginia.

TABLE 6.—Burley Smoker, Moisture-Free, 1921 Crop.

Number of Sample	Good			Medium			Common		
	Total N Per Cent	Nicotine Per Cent	Nitrate N Per Cent	Total N Per Cent	Nicotine Per Cent	Nitrate N Per Cent	Total N Per Cent	Nicotine Per Cent	Nitrate N Per Cent
80124, 5, 6	3.50	3.13	.562	3.96	1.90	1.367	3.30	2.48	.365
80132, 3, 4	4.35	4.90	1.121	2.76	1.67	.571	3.99	1.55	.622
80251a, 2a, 3a	2.98	2.82	.054	3.32	2.21	.159	3.09	1.61	.699
80274b, 5b, 6b	2.54	2.08	.043	3.77	1.78	.681	3.28	.95	.867
80297c, 8c, 9c	3.36	3.38	.317	3.83	3.35	.821	3.27	2.13	.545
80330c, 1c, 2c	4.87	4.15	.715	3.66	2.93	.700	3.77	1.99	1.048
80353c, 4c, 5c	4.33	2.82	.624	3.61	2.84	.559	3.34	1.16	.925
Maximum	4.87c	4.90	1.121	3.96	3.35c	1.367	3.99	2.48	1.048c
Minimum	2.54b	2.08b	.043b	2.76	1.67	.159a	3.00a	.95b	.365
Average	3.70	3.33	.491	3.56	2.39	.694	3.42	1.70	.724

a—Association grade B (trash).

b—Association grade A (flyings).

c—Association grade C (lugs).

TABLE 7.—Dark Leaf, Moisture-Free, 1920 Crop.

Number of Sample	Good			Medium			Common		
	Total N Per Cent	Nicotine Per Cent	Nitrate N Per Cent	Total N Per Cent	Nicotine Per Cent	Nitrate N Per Cent	Total N Per Cent	Nicotine Per Cent	Nitrate N Per Cent
Fire cured—									
61436a, 7a	4.55	7.30	.150	.....	.....	.....	3.27	5.51	.099
61452, 3	4.90	5.29	.163	.....	.....	.....	4.54	5.51	.114
61514, 5	4.77	4.47	.141	.....	.....	.....	4.10	2.59	.132
61521, 2, 3	3.96	6.25	.093	4.12	4.06	.011	4.01	5.72	.066
61553b, 4b, 5b	3.89	7.37	.060	4.26	4.84	.337	3.82	5.60	.110
61602c	3.97	6.12	.020	.....	.....	.....	.....	.....	.....
61630d	.....	.....	.....	.....	.....	.....	3.02	4.18	.045
Air cured—									
61469, 70	4.27	7.01	.121	.....	.....	.....	4.83	6.16	.176
61603	3.46	4.93	.026	.....	.....	.....	.....	.....	.....
Maximum	4.90	7.37b	.163	4.26b	4.84b	.337b	4.83	6.16	.176
Minimum	3.46	4.47	.020c	4.12	4.06	.011	3.02d	2.59	.009a
Average	4.22	6.09	.097	4.19	4.45	.174	4.10	5.18	.101

a—Blue Pryor variety.

b—Little Crittenden variety.

c—Used for plug wrapper.

d—1919 crop, omitted from average.

TABLE 8.—Dark Leaf, Moisture-Free, 1921 Crop.

Number of Sample	Good			Medium			Common		
	Total N Per Cent	Nicotine Per Cent	Nitrate N Per Cent	Total N Per Cent	Nicotine Per Cent	Nitrate N Per Cent	Total N Per Cent	Nicotine Per Cent	Nitrate N Per Cent
Fire cured—									
80090, 1	4.63	4.84	.328	.....	.....	.....	4.60	6.67	.298
80143a, 4a	4.26	6.87	.392	.....	.....	.....	4.43	7.67	.131
80151, 2	4.92	7.15	.311	3.87	5.67	.326	.....	.....	.....
80159, 60	4.07	7.48	.110	.....	.....	.....	3.93	6.31	.153
80230a, 1a	4.54	7.50	.431	4.31	7.02	.207	.....	.....	.....
8032b	4.93	7.78	.250	.....	.....	.....	.....	.....	.....
80383, 4	5.03c	6.99c	.225c	.....	.....	.....	4.24d	5.74d	.187d
Air cured—									
80073e, 4e, 5e	4.74	6.79	.109	4.35	6.01	.211	3.74	5.09	.190
80076f, 7f	4.94	4.92	.441	.....	.....	.....	5.75	4.24	.730
80094	4.26	5.43	.186	.....	.....	.....	.....	.....	.....
80095, 6	4.51	6.45	.108	.....	.....	.....	4.29	5.78	.154
80111a, 2a	4.69	7.15	.356	.....	.....	.....	5.01	6.03	.283
80154, 5, 6	4.77	6.31	.498	4.30	5.24	.206	4.60	5.61	.421
80192, 3	4.21	7.14	.280	.....	.....	.....	3.81	6.23	.278
80234a, 5a	4.38	7.44	.220	4.32	7.22	.175	.....	.....	.....
80236a, 7a	3.70	6.87	.036	.....	.....	.....	3.35	6.00	.044
Maximum	5.03c	7.78b	.498	4.35e	7.22a	.326	5.75f	7.67a	.730f
Minimum	3.70a	4.84	.036a	3.87	5.24	.175a	3.35a	4.24f	.044a
Average	4.53	6.69	.268	4.23	6.23	.225	4.34	5.94	.261

a—Little Crittenden variety.

b—Snuff type.

c—Cigar type.

d—French type.

e—Manufacturing type.

f—Rehandling type.

TABLE 9.—Dark Lugs, Moisture-Free, 1920 Crop.

Number of Sample	Good			Medium			Common		
	Total N Per Cent	Nicotine Per Cent	Nitrate N Per Cent	Total N Per Cent	Nicotine Per Cent	Nitrate N Per Cent	Total N Per Cent	Nicotine Per Cent	Nitrate N Per Cent
Fire cured—									
61438a, 9a	4.65	5.13	.154	.....	.....	.....	3.84	5.24	.066
61454	4.66	4.66	.224	.....	.....	.....	.....	.....	.....
61456	.....	.....	.....	3.04	4.24	.108	.....	.....	.....
61516, 7	2.78	4.91	.044	.....	.....	.....	3.44	2.30	.045
61556b, 7b	3.86	6.59	.099	.....	.....	.....	4.72	4.26	.390
61604	2.41	3.96	.013	.....	.....	.....	.....	.....	.....
61631c	3.12	5.01	1.04	.....	.....	.....	.....	.....	.....
Air cured—									
61471, 2	3.42	4.44	.320	.....	.....	.....	4.07	6.46	.206
61605	.....	.....	.....	.....	.....	.....	2.88	2.59	.054
Maximum	4.66	6.59b	.320	.....	.....	.....	4.72b	6.46	.390b
Minimum	2.41	3.96	.013	.....	.....	.....	2.88	2.30	.045
Average	3.63	4.95	.142	.....	.....	.....	3.79	4.17	.152

a—Blue Pryor variety.

b—Little Crittenden variety.

c—1919 crop, omitted from average.

TABLE 10.—Dark Lugs, Moisture-Free, 1921 Crop.

Number of Sample	Good			Medium			Common		
	Total N Per Cent	Nicotine Per Cent	Nitrate N Per Cent	Total N Per Cent	Nicotine Per Cent	Nitrate N Per Cent	Total N Per Cent	Nicotine Per Cent	Nitrate N Per Cent
Fire cured—									
80092, 3	3.06	4.38	.115	.....	.....	.....	3.53	3.58	.385
80145a, 6a	4.24	6.86	.282	.....	.....	.....	4.35	4.94	.275
80153	3.80	5.44	.397	.....	.....	.....	.....	.....	.....
80162, 3	4.03	5.67	.312	.....	.....	.....	4.36	6.10	.360
80222a, 3a	3.43	7.40	.137	3.45	5.87	.114	.....	.....	.....
80385b	.....	.....	.....	4.16	5.43	.176	.....	.....	.....
80386c	.....	.....	.....	3.51	5.35	.240	.....	.....	.....
Air cured—									
80078d, 9d	2.95	4.50	.049	.....	.....	.....	3.05	5.29	.072
80080e	.....	.....	.....	.....	.....	.....	3.46	4.29	.516
80097, 8	3.54	5.01	.157	.....	.....	.....	3.76	2.89	.244
80113a, 4a	4.41	6.37	.427	.....	.....	.....	5.08	5.19	.523
80194, 5	3.57	6.27	.191	.....	.....	.....	4.47	7.83	.311
80238a, 9a	3.29	6.28	.059	.....	.....	.....	2.89	5.85	.049
Maximum	4.41a	7.40a	.427a	4.16b	5.87a	.240c	5.08a	7.83	.523a
Minimum	2.95d	4.38	.049d	3.45a	5.35e	.114a	2.89a	2.89	.049a
Average	3.63	5.82	.213	3.71	5.55	.177	3.88	5.11	.304

a—Little Crittenden variety.

b—Dark type.

c—Bright type.

d—Manufacturing type.

e—Rehandling.

TABLE 11.—Dark Trash, Moisture-Free, 1920 Crop.

Number of Sample	Good			Medium			Common		
	Total N Per Cent	Nicotine Per Cent	Nitrate N Per Cent	Total N Per Cent	Nicotine Per Cent	Nitrate N Per Cent	Total N Per Cent	Nicotine Per Cent	Nitrate N Per Cent
Fire cured—									
61440a	.....	.....	.....	.....	.....	.....	3.42	4.77	.067
61455	2.83	3.33	.148	.....	.....	.....	.....	.....	.....
61457	.....	.....	.....	2.47	3.19	.043	.....	.....	.....
61518, 9	2.25	3.99	.036	.....	.....	.....	2.45	2.27	.195
61558b, 9b	2.81	3.75	.002	.....	.....	.....	2.07	2.12	.015
61606	.....	.....	.....	.....	.....	.....	2.76	2.83	.028
61632	.....	.....	.....	.....	.....	.....	3.24	3.76	.065
Air cured—									
61473	.....	.....	.....	.....	.....	.....	2.52	2.36	.044
Maximum	2.83	3.99	.148	.....	.....	.....	3.42a	4.77a	.195
Minimum	2.25	3.33	.002b	.....	.....	.....	2.07b	2.12b	.015b
Average	2.63	3.69	.062	.....	.....	.....	2.74	3.02	.069

a—Blue Pryor variety.

b—Little Crittenden variety.

TABLE 12.—Dark Trash, Moisture-Free, 1921 Crop.

Number of Sample	Good			Medium			Common		
	Total N Per Cent	Nicotine Per Cent	Nitrate N Per Cent	Total N Per Cent	Nicotine Per Cent	Nitrate N Per Cent	Total N Per Cent	Nicotine Per Cent	Nitrate N Per Cent
Fire cured—									
80147a, 8a	3.58	6.66	.404	.....	.....	.....	3.29	3.32	.151
80163, 4	2.83	4.96	.100	.....	.....	.....	3.16	4.95	.401
80224a, 5a	2.87	5.48	.131	3.90	5.65	.185	.....	.....	.....
80387, 8, 9	3.81	3.92	.382	3.70	4.46	.155	2.91	4.64	.156
Air cured—									
80081, 2	2.90b	4.45b	.157b	.....	.....	.....	2.81c	3.73c	.247c
80099, 100	3.85	3.01	.486	.....	.....	.....	3.16	3.12	.329
80115a, 6a	3.73	5.41	.240	.....	.....	.....	3.95	3.79	.099
80196, 7	2.27	4.12	.041	.....	.....	.....	2.70	3.24	.174
Maximum	3.85	6.66a	.486	3.90a	5.65a	.185a	3.95a	4.95	.401
Minimum	2.27	3.01	.041	3.70	4.46	.155	2.70	3.12	.099a
Average	3.23	4.75	.243	3.80	5.06	.170	3.14	3.83	.222

a—Little Crittenden variety.

b—Manufacturing type.

c—Rehandling type.

TABLE 13.—Yearly Average of Constituents in Tobacco Leaf, Moisture-Free, from Tables 1 to 12, Inclusive.

	Good			Medium			Common		
	Total N Per Cent	Nicotine Per Cent	Nitrate N Per Cent	Total N Per Cent	Nicotine Per Cent	Nitrate N Per Cent	Total N Per Cent	Nicotine Per Cent	Nitrate N Per Cent
Burley wrapper—									
1920	4.21	3.93	.254	4.15	4.14	.262	.....	.....	.....
1921	3.89	3.80	.367	3.87	3.90	.375	.....	.....	.....
Average*	4.09	3.88	.298	3.98	3.99	.331	.....	.....	.....
Burley filler—									
1920	4.88	4.16	.396	4.17	4.12	.213	4.18	2.96	.108
1921	4.86	3.79	.507	4.72	3.48	.345	4.44	2.81	.519
Average*	4.87	3.94	.463	4.50	3.74	.292	4.30	2.89	.303
Burley smoker—									
1920	3.21	2.64	.149	3.10	2.11	.150	3.23	1.59	.175
1921	3.70	3.33	.491	3.56	2.39	.694	3.42	1.70	.724
Average*	3.44	2.96	.309	3.35	2.26	.443	3.31	1.63	.401
Dark leaf—									
1920	4.22	6.09	.097	4.19	4.45	.174	4.10	5.18	.101
1921	4.53	6.69	.268	4.23	6.23	.225	4.34	5.94	.261
Average*	4.43	6.49	.211	4.22	5.72	.210	4.25	5.67	.204
Dark lugs—									
1920	3.63	4.95	.142	3.04	4.24	.108	3.79	4.17	.152
1921	3.63	5.82	.213	3.71	5.55	.177	3.88	5.11	.304
Average*	3.63	5.49	.186	3.54	5.22	.160	3.85	4.77	.250
Dark trash—									
1920	2.63	3.69	.062	2.47	3.19	.043	2.74	3.02	.069
1921	3.23	4.75	.243	3.80	5.06	.170	3.14	3.83	.222
Average*	3.07	4.46	.193	3.36	4.43	.128	2.96	3.45	.152

*This is the average of the total number of samples of the character indicated that were analyzed of the crop from both years, not the mean of the yearly averages.

TABLE 14.—Total Nitrogen, Nicotine and Nitrate Nitrogen in Tobacco Leaf, Moisture-Free, 1920 and 1921 Crops.

	No. of Samples	A Total N* Per Cent	Nicotine* Per Cent	B Nicotine Per Cent	C Nitrate N* Per Cent	A—(B+C)
Burley—						
1920	59	3.85	3.07	.530	.202	3.118
1921	61	4.12	3.16	.546	.501	3.073
Average**	120	3.99	3.12	.539	.354	3.097
Dark—						
1920	38	3.61	4.63	.800	.108	2.702
1921	71	3.93	5.62	.971	.246	2.713
Average**	109	3.82	5.28	.912	.198	2.710

*Average of all determinations on all grades in Tables 1 to 12 inclusive.

**This is the average of the total number of samples of the character indicated that were analyzed of the crops from both years, not the mean of the yearly averages.

TABLE 15.—Mineral Constituents in Burley Tobacco Leaf, Moisture-Free, 1920 and 1921 Crops.

	Wrapper		Filler		Smoker	
	Good* Per Cent	Medium* Per Cent	Good* Per Cent	Common* Per Cent	Good* Per Cent	Common* Per Cent
1920						
Crude ash	21.32	20.62	20.24	18.76	22.79	25.13
Silicon (Si.)	.40	.28	.42	.54	.55	1.94
Phosphorus (P.)	.33	.36	.35	.34	.41	3.44
Potassium (K.)	4.56	4.69	4.00	3.61	4.36	3.14
Calcium (Ca.)	4.53	4.19	4.42	3.94	5.22	6.30
Magnesium (Mg.)	.54	.61	.80	.64	.56	.54
1921						
Crude ash	21.44	21.75	20.52	22.82	22.43	28.82
Silicon (Si.)	.58	.62	.56	1.90	.86	2.56
Phosphorus (P.)	.34	.32	.43	.47	.35	.40
Potassium (K.)	4.27	4.94	4.23	2.54	4.89	3.89
Calcium (Ca.)	2.59	2.84	4.74	3.78	2.77	3.84
Magnesium (Mg.)	.66	.62	.65	.71	.66	.79
Average,** 1920-1921						
Crude ash	21.38	21.19	20.38	20.79	22.61	26.98
Silicon (Si.)	.49	.45	.49	1.22	.71	2.25
Phosphorus (P.)	.34	.34	.39	.41	.38	.42
Potassium (K.)	4.32	4.82	4.12	3.08	4.63	3.52
Calcium (Ca.)	3.56	3.52	4.58	3.86	4.00	4.57
Magnesium (Mg.)	.60	.62	.73	.68	.61	.67

*Analysis of a composite of all of this character in Tables 1 to 6, inclusive.

**Mean of both years in above tables.

TABLE 16.—Mineral Constituents in Dark Tobacco Leaf, Moisture-Free, 1920 and 1921 Crops.

	Leaf		Lugs		Trash	
	Good* Per Cent	Common* Per Cent	Good* Per Cent	Common* Per Cent	Good* Per Cent	Common* Per Cent
1920						
Crude ash	17.10	17.69	21.80	20.91	27.93	26.86
Silicon (Si.)	1.24	1.30	2.36	2.52	4.31	3.99
Phosphorus (P.)	.24	.24	.25	.21	.24	.20
Potassium (K.)	2.59	2.69	2.70	2.32	1.84	2.32
Calcium (Ca.)	2.91	3.22	3.62	3.40	3.76	3.72
Magnesium (Mg.)	.93	1.01	.87	.92	1.09	1.00
1921						
Crude ash	18.53	19.10	23.31	24.02	26.05	28.03
Silicon (Si.)	1.37	2.03	3.10	3.75	4.09	4.55
Phosphorus (P.)	.23	.21	.19	.19	.18	.18
Potassium (K.)	3.38	2.98	2.84	2.87	2.86	2.85
Calcium (Ca.)	3.46	3.06	1.16	3.43	1.09	2.03
Magnesium (Mg.)	.95	.99	1.15	1.06	1.20	1.19
Average, ** 1920-1921						
Crude ash	17.82	18.40	22.56	22.47	26.99	27.45
Silicon (Si.)	1.31	1.67	2.73	3.14	4.20	4.27
Phosphorus (P.)	.24	.23	.22	.20	.21	.19
Potassium (K.)	2.99	2.84	2.77	2.60	2.35	2.59
Calcium (Ca.)	3.19	3.14	2.39	3.42	2.43	2.88
Magnesium (Mg.)	.94	1.00	1.01	.99	1.15	1.10

*Analysis of a composite sample of all of this character in Tables 7 to 12, inclusive.

**Mean of the findings for the two years in above tables.

TABLE 17.—Comparison of Some Mineral Constituents in Burley and Dark Tobacco Leaf, Moisture-Free, 1920 and 1921 Crops.

	Crude Ash* Per Cent	Silicon* Si. Per Cent	Phosphorus* P. Per Cent	Potassium* K. Per Cent	Calcium *Ca Per Cent	Magnesium* Mg. Per Cent
Burley						
1920	21.48	.69	.37	4.03	4.60	.62
1921	22.96	1.18	.39	4.13	3.43	.68
Average	22.22	.93	.38	4.08	4.01	.65
Dark						
1920	22.05	2.62	.23	2.41	3.44	.97
1921	23.17	3.15	.20	2.96	2.37	1.09
Average	22.61	2.88	.21	2.69	2.91	1.03

*Average of all determinations on all grades in Tables 15 and 16.

**EFFECT OF LEAF-SPOT DISEASE ON THE CONTENT OF
NITROGEN AND NICOTINE IN TOBACCO LEAF**

The diseases known as wildfire and angular leaf-spot were prevalent in 1920, particularly in the burley region, but probably to a less extent in the dark tobacco section. This was the first year that wildfire was recognized here. It was the opinion of competent observers that the 1920 crop of burley was one of the worst in quality ever produced in this locality.

In addition to the samples previously described, the writer collected a large number of "hands" of burley tobacco from the 1920 crop for use in some experiments carried on with Prof. A. J. Olney, of this Station, on the preparation of a reliable tobacco solution for spraying (9). These "hands" consisted of very common leaf which was infected with leaf-spot disease, very poorly graded, and otherwise damaged. This kind of tobacco sold for from fifty cents to two dollars per hundredweight, which, of course, was below the cost of production; but this probably is the only kind of leaf that can be used economically in a spray solution. This tobacco was known on the market as very common trash and, even if it had been properly graded, its quality and value would have been below that of the samples included under common in Tables 3 to 6, inclusive, on account of its more diseased condition. A "hand" often contained a mixture of inferior smoker, filler and tips. This trash should not be confused with the Association grade B-7 (common trash) which is composed of only one kind of leaf.

The determinations made were total nitrogen and nicotine, and it was observed that while the nicotine content was generally small, the corresponding nitrogen content was not always low. This is shown in Tables 18 and 19.

In Table 18 the percentages of nitrogen and nicotine in this burley trash are compared with the percentages of the same constituents found in the common grades of fillers and smokers given in Tables 3 to 6, inclusive. It will be seen that the nitrogen content of the burley trash lies between that of the fillers and smokers, whereas its nicotine content, the lowest, is practically the same as that of the smokers.

As the samples of burley trash were mixed grades containing filler, smoker and tip leaves, all more or less damaged and diseased, it would be expected that their average nitrogen and nicotine content would fall between those of the other two grades. As a matter of fact, the nitrogen content is intermediate but the nicotine content is smaller than in the other two. This may be explained by the effect of disease on the nicotine content, as shown in Table 19.

There was a considerable amount of burley tobacco in the 1920 crop which cured with a green color. The "hands" were, in numerous instances composed of large leaves of uniform size and relatively free from disease, but on account of their green color they could not be graded; consequently they were known as trash, or green tobacco, and sold for a very low price. It was demonstrated, however, that much of this tobacco, when properly bulked for a sufficient time or put thru the drying process, would assume a normal color and could then be graded properly. For this reason, therefore, such tobacco could not be classed along with the diseased trash samples mentioned above. Two samples of this green tobacco were found to contain 4.60 per cent and 4.84 per cent total nitrogen and 2.21 per cent and 2.69 per cent nicotine.

A comparison of the common dark samples is given in Table 18. The considerations that dark trash is a distinct grade composed of leaves obtained from a different part of the stalk from this burley trash, and that it was not affected with as much disease as the burley tobacco, afford an explanation why the relation shown among the findings for the burley does not hold true for the dark tobacco.

Some of this burley trash was separated into two lots, one of which was appreciably and the other badly infected with leaf-spot disease; otherwise their appearance was the same. Comparisons were made also with samples of similar leaf in one of which the midrib was present and in the other it had been removed. These results are given in Table 19.

TABLE 18.—Average Total Nitrogen and Nicotine in Common Grades of Tobacco, Moisture-Free, 1920 and 1921 Crops.

Grade	Number of Samples	Nitrogen Per Cent	Nicotine Per Cent
Common burley fillers	19	4.30	2.89
Common burley smokers	17	3.31	1.63
Common burley trash*	8	3.74	1.61
Common dark leaf	17	4.25	5.67
Common dark lugs	14	3.85	4.77
Common dark trash	13	2.96	3.45

*Each sample of burley common trash consisted of a "hand" containing very common filler, smoker and tip leaves of the 1920 crop, that were either diseased or damaged and sold for a very low price. This trash should not be confused with the Association grade, B-7 (common trash) given in the preceding tables.

TABLE 19.—Total Nitrogen and Nicotine in Burley Common Trash, Moisture-Free, Infected with Leaf Spot Disease, 1920 Crop.*

Appreciably Infected			Badly infected.		
Number of Sample	Nitrogen Per Cent	Nicotine Per Cent	Number of Sample	Nitrogen Per Cent	Nicotine Per Cent
Leaf including midrib or stem.					
61476	4.77	1.33	61481	4.52	1.04
61477	2.42	1.00	61482	3.57	.94
61478	2.63	.95	61483	2.81	.92
61479	3.87	3.17	61484	3.15	.75
61480	2.45	.75	61485	3.65	1.06
			61486	4.25	1.01
			61487	4.44	1.40
			61488	3.46	.99
			61489	4.61	1.16
			61490	3.56	1.01
Average (5 samples)	3.23	1.44	Average (10 samples)	3.80	1.03
Leaf, not including midrib or stem.					
61476 to 80 inc.	3.71a	2.02a	61481 to 90 inc.	4.42b	1.35b
61408	4.60	2.21	61346	5.60	2.96
61410	4.84	2.69	61421	1.96	.29
			61422	3.20	1.33
			61423	4.13	2.23
			61424	3.72	2.78
			61425	3.23	.95
			61426	4.14	.75
			61427	3.96	1.58
Average (7 samples)	4.00	2.15	Average (18 samples)	4.12	1.47

*Each sample of common trash consisted of a "hand" containing very common filler, smoker and tip leaves that were either diseased or damaged and sold for a very low price. This trash should not be confused with the Association grade B-7 (common trash) given in the preceding tables.

a—Composite of 5 samples, Nos. 61476 to 80, inclusive, not including midrib or stem.

b—Composite of 10 samples, Nos. 61481 to 90, inclusive, not including midrib or stem.

DISCUSSION OF RESULTS AND CONCLUSIONS

The averages of all individual determinations of nitrogen, nicotine and nitrate made on the burley and dark tobacco of both years, as given in Table 13, show the following relations between the different grades:

Burley Wrapper. Good has slightly more nitrogen than medium but somewhat less nicotine and nitrate. The differences are small.

Burley Filler. Good has the most nitrogen, nicotine and nitrate. Medium has more nitrogen and nicotine than common but about the same nitrate.

Burley Smoker. Good has more nitrogen and nicotine but less nitrate than the other grades. Medium has about the same nitrogen, more nicotine and slightly more nitrate than common. The differences in nitrogen are not as large, however, as in some other grades.

Dark Leaf. Good has more nitrogen and nicotine than the other grades, but about the same nitrate. Medium contains about the same nitrogen, nicotine and nitrate as the common.

Dark Lugs. Good contains somewhat more nitrogen and nitrate than medium but has less than common. It has the most nicotine. Medium contains less nitrogen and nitrate but more nicotine than common.

Dark Trash. Good contains less nitrogen than medium but more than common. It has about the same nicotine as medium but more than common; also more nitrate than the others. Medium has more nitrogen and nicotine but slightly less nitrate than common.

Referring to the burley in the same table, it will be found that the fillers usually contain the most nitrogen and nicotine and the smokers the least. The nitrate is more variable but the smokers compare favorably with the other grades regarding this constituent; in fact, the medium and common carry some of the largest amounts.

The same table also shows that the dark leaf usually carries the most nitrogen, nicotine and nitrate and the trash generally the least of these constituents.

Table 14 shows that, comparing all grades of each kind of tobacco of each year, the tobacco grown in 1921, both burley and dark, contains more of all three constituents than that grown in 1920. Again, on comparing the burley and dark samples, it is apparent that the burley tobacco carries more nitrogen and nitrate than the dark tobacco, but less nicotine than the latter, in both years. The combined burley samples contain 4.5 per cent more nitrogen and 78.8 per cent more nitrate but 40.9 per cent less nicotine than the combined dark.

The same table shows, also, in the case of the burley, that if the sum of the nitrogen in nicotine and nitrate be taken from the total nitrogen the remainder is about the same for each year, for each kind of tobacco, but the amount is less in the dark tobacco than in the burley.

The averages of the mineral constituents in the different grades of each kind of tobacco for the two years, as given in Tables 15 and 16, show the following relations:

Burley Wrapper. Good has slightly more ash but considerably less potassium than the medium.

Burley Filler. Good has less ash and silicon but more potassium and calcium than the common.

Burley Smoker. Good has less ash, silicon and calcium but more potassium than the common.

Dark Leaf. Good has less ash and silicon but more potassium than the common.

Dark Lugs. Good has less silicon and calcium but more potassium than the common.

Dark Trash. Good has less ash, potassium and calcium than the common.

The findings suggest that the good tobacco usually has a larger percentage of potassium than the common of the same class, but further work on individual samples is necessary to establish this point. The writer is now making the necessary analyses to test this question more fully.

The percentages of constituents not mentioned in any of the foregoing comparisons between good and common are about the same in both.

If the mean of the averages for good and common of each burley grade, calculated from the two-year average given in Table 15, is used as a basis of comparison, it will be found that the wrappers have the least silicon and calcium but the most potassium; the fillers, the least ash and potassium; and the smokers the most ash, silicon and calcium. The phosphorus and magnesium are more nearly constant than the remaining constituents. The same comparison of the dark grades in Table 16 shows the leaf to have the least ash and silicon but the most potassium and calcium, while the trash has the most ash and silicon but the least potassium and calcium. The phosphorus and magnesium are again nearly constant.

Table 17 shows that the 1921 samples of burley have more ash and silicon but less calcium than the 1920 crop. The other constituents are nearly equal. The 1921 samples of dark tobacco have more ash, silicon and potassium, but less calcium than those of 1920, while the other constituents show little variation.

The same table also shows that the 1920 samples of burley have less ash, silicon and magnesium but more phosphorus, potassium and calcium than the dark samples of the same year. The same relations hold true concerning the 1921 samples. The combined burley samples have 1.7 per cent less ash, 67.7 per cent less silicon and 36.9 per cent less magnesium, but 81.0 per cent more phosphorus, 51.7 per cent more potassium and 37.8 per cent more calcium than the combined dark.

Referring to the burley averages in Table 18, it will be seen that the trash has the least nicotine but not the lowest nitrogen content. As this trash was composed of mixed filler, smoker and tip leaves which were more or less diseased, it would be expected that the amounts of these two constituents present in it would be intermediate between the amounts of the same constituents found in the other two grades, were it not for the fact that disease evidently has affected the nicotine content but not the nitrogen content of these samples, as shown in Table 19.

The averages for dark tobacco, in the same table, show that the trash contains the least nicotine and nitrogen. The fact that the dark trash is composed of leaves obtained from a different

portion of the stalk from that from which the burley trash comes, and were freer from disease, may account for this.

Table 19 shows that the presence of the stem in the leaf lowers the nitrogen and nicotine content. It also shows that the leaf, with or without the stem, that was badly infected with leaf-spot disease has less nicotine but more nitrogen than that only partly infected. As a further comparison in order to demonstrate this, it might be mentioned that the averages of all other burley samples grown in the same year, 1920, given in Table 14, show 3.85 per cent nitrogen and 3.07 per cent nicotine. They were, with few possible exceptions, of higher quality and freer of disease than the trash. The averages in Table 19 for partly infected leaf are 4.00 per cent nitrogen and 2.15 per cent nicotine, while those for badly infected leaf are 4.12 per cent nitrogen and 1.47 per cent nicotine. This indicates that either the diseased leaf had a part of its nitrogen in combinations which were detrimental or the deficiency of nicotine vitiated its quality.

SUMMARY

1. This investigation is a comparative study of the total content of nitrogen, nicotine, nitrate nitrogen, crude ash, silicon, phosphorus, potassium, calcium and magnesium found in the different grades of tobacco represented by 145 samples of burley and 109 samples of dark tobacco grown in Kentucky in 1920 and 1921. The mineral constituents were determined on composite samples but the other determinations were made on the individual samples.

2. The burley crop of 1920 was abnormal, being infected to an unusual degree with leaf-spot diseases. The dark tobacco of that year employed in this investigation, was less diseased than the burley. Both burley and dark tobacco samples taken from the 1921 crops were more nearly normal, as they were freer of disease. This affords a comparison of abnormal versus normal leaf, as well as variations in different years.

3. The good division of any grade usually contained a larger percentage of nicotine than the common. The nitrogen

and nitrate were more variable but in the majority of instances, the good carried larger percentages of these constituents than the common.

4. A comparison of the burley grades shows that the fillers usually contain the largest percentages of nitrogen and nicotine and the smokers, the smallest. In the dark tobacco the leaf usually has the largest percentage of nitrogen, nicotine and nitrate, and the trash the smallest.

5. The burley tobacco of 1921 contained larger percentages of all constituents determined, except calcium, than that of 1920. The dark tobacco of 1921 also carried larger percentages of all except calcium and phosphorus, than that of 1920. The proportions of phosphorus and magnesium, altho different in the two kinds of tobacco, showed the least variation in the same crop, in the two years.

6. The burley tobacco of each year contained larger percentages of nitrogen and nitrate but a smaller percentage of nicotine than the dark tobacco. The combined burley samples showed 4.5 per cent more nitrogen and 78.8 per cent more nitrate nitrogen, but 40.9 per cent less nicotine than the dark.

7. The ranges for the nitrogen constituents determined in the dry burley were 1.96 to 6.05 per cent total nitrogen, 0.29 to 6.18 per cent nicotine, and 0.009 to 1.37 per cent nitrate nitrogen. For the dry dark tobacco they were 2.07 to 5.75 per cent total nitrogen, 2.12 to 7.83 per cent nicotine, and 0.002 to .73 per cent nitrate nitrogen.

8. The proportions of the ash constituents, other than phosphorus and magnesium, differed considerably in the good and common grades. The good, apparently, had the most potassium, but further work on individual samples is necessary to establish this point.

9. The averages obtained for burley tobacco apparently show that the wrappers have the smallest percentages of silicon and calcium but the largest potassium; the fillers, the smallest percentages of ash and potassium, and the smokers the largest percentages of ash, silicon and calcium. The averages for dark tobacco show that the leaf has the smallest percentages of ash

and silicon but the largest of potassium and calcium, while the trash has the largest percentages of ash and silicon but the smallest of potassium and calcium.

10. The burley tobacco of each year contained smaller percentages of ash, silicon and magnesium, but larger percentages of phosphorus, potassium and calcium than the dark tobacco of the corresponding year. The averages of the analyses of burley tobacco representing the two years show 1.7 per cent less ash, 67.7 per cent less silicon and 36.9 per cent less magnesium, but 81.0 per cent more phosphorus, 51.7 per cent more potassium and 37.8 per cent more calcium than the corresponding averages for the dark tobacco.

11. Burley leaf which was badly infected with leaf-spot disease contained a considerably smaller percentage of nicotine but a larger percentage of nitrogen than that which was less diseased. This indicates that such tobacco either had part of its nitrogen in combinations which were detrimental or the deficiency of nicotine vitiated its quality.

LITERATURE CITED

1. Association of Official Agricultural Chemists, 1920. Official and Tentative Methods of Analysis. As compiled by the Committee on Revision of Methods. Published by the Association, Washington, D. C.
2. Bohannon, C. D., and Campbell, D. P., 1916. A preliminary study of the marketing of burley tobacco in Central Kentucky. Ky. Agr. Exper. Sta., Bull. No. 202, p. 161.
3. Carpenter, F. B., 1895. Types of tobacco and their analyses. N. C. Agr. Exper. Sta., Bull. No. 122.
4. Davidson, R. J., 1892. Chemistry of the tobacco plant. Va. Agr. Exper. Sta., Bull. No. 14.
1895. Analyses of parts of the tobacco plant at different stages of growth. Va. Agr. Exper. Sta. Bull. No. 50.
1895. Percentage of nicotine in tobacco. Va. Agr. Exper. Sta. Bull. No. 52.
5. Graham, Vere, and Carr, R. H., 1924. Chemical factors determining the quality of tobacco. In Jour. Am. Chem. Soc., Vol. 46, No. 3, pp. 695-702.
6. Peter, Robert, Ky. Geol. Survey, 4th Rept., 1858-1859, pp. 293-309, Frankfort, Ky., 1861.
7. Shedd, O. M., 1923. An improved method for the determination of nicotine in tobacco and tobacco extracts. In Jour. Agr. Res., Vol. 24, No. 11, pp. 961-70.
8. Do. 1924. The determination of nitrate and ammonia in nitrogenous materials. In Jour. Agr. Res., Vol. 28, No. 6, pp. 527-39.

9. Do. and Olney, A. J., 1924. The preparation from tobacco of a solution for spraying. Paper read at the symposium on insecticides and fungicides of the American Chemical Society at their meeting in Washington, D. C., Apr. 21-25, 1924, and published in the Jour. Econ. Ent., Vol. 17, No. 6, pp. 650-6.